

CLAIMS

1. An image processing apparatus comprising:  
a contrast improvement unit operable to perform a contrast improvement process on an input image by comparing an object pixel of the input image with pixels that belong to surrounding areas of the object pixel;  
an image combination unit operable to combine an enhanced image obtained by the contrast improvement unit and the input image; and  
an image output unit operable to output the image after combination.  
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2. The image processing apparatus of claim 1 wherein  
the contrast improvement unit comprises: a correction data calculation unit operable to find a contrast improvement amount for a pixel in the input image; an extraction unit operable to extract an effective range from distribution of the contrast improvement amount; and a pixel value conversion unit operable to convert a contrast improvement amount of the object pixel to a value of a corresponding pixel in the enhanced image according to the extracted range.  
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3. The image processing apparatus of claim 1 wherein  
the contrast improvement unit comprises: a correction data calculation unit operable to find a contrast improvement amount by comparing the object pixel with pixels that belong to each of surrounding areas with different sizes; an extraction unit operable to extract an effective range from distribution of the contrast improvement amount; and a pixel value conversion unit operable to convert a contrast improvement amount of the object pixel to a value of a corresponding pixel in the enhanced image according to the extracted range.  
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4. The image processing apparatus of claim 2 or 3 wherein  
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the pixel value conversion unit comprises: an average brightness calculation unit operable to calculate an average brightness of pixels in the input image; a conversion method selection unit operable to select a method of converting a contrast improvement amount to a value of pixel  
5 in the enhanced image based on the average brightness; and a pixel value estimation unit operable to convert the contrast improvement amount to a value of pixel in the enhanced image according to the selected conversion method.

10 5. The image processing apparatus of claim 2 or 3 wherein  
the pixel value conversion unit comprises: a standard intensity calculation unit operable to calculate a standard intensity value that indicates contrast intensity of the input image; a conversion curve estimation unit operable to estimate a conversion curve for converting  
15 the contrast improvement amount to a value in the enhanced image based on the standard intensity value; and a pixel value estimation unit operable to use the conversion curve to convert the contrast improvement amount to a value in the enhanced image.

20 6. The image processing apparatus of claim 5 wherein  
the conversion curve estimation unit comprises: an initial candidate setting unit operable to set an initial population of search vectors that indicate conversion curves; a pixel value conversion candidate calculation unit operable to find a conversion value in a candidate for an enhanced  
25 image from the contrast improvement amount using a conversion curve candidate corresponding to each search vector; an evaluation value calculation unit operable to use the standard intensity value and the conversion value to calculate an evaluation value for evaluating the candidates of each conversion curve; a fitness calculation unit operable  
30 to calculate fitness of a candidate of each conversion curve based on the

evaluation value; a recombination operation unit operable to perform recombination operation on a search vector selected based on the fitness of the candidates of each conversion curve and generate a next generation population; and an estimation end judgment unit operable to determine  
5 whether or not estimation of the conversion curve ends at a current generation.

7. The image processing apparatus of claim 1 wherein  
the contrast improvement unit comprises: a signal conversion unit  
10 operable to convert a value of pixel in the input image to a plurality of signals that include a signal that is an object of contrast improvement; an object correction data calculation unit operable to find a contrast improvement amount of the object pixel for an object signal obtained from the signal conversion unit; an extraction unit operable to extract an  
15 effective range from distribution of the contrast improvement amount for the object signal; an object signal conversion unit operable to convert the contrast improvement amount for the object signal to a value of the object signal in the enhanced image; and a signal inverse conversion unit operable to find a value of pixel in the enhanced image based on the object  
20 signal of the enhanced image and signals other than the object signal obtained by the signal conversion unit.

8. The image processing apparatus of claim 1 wherein  
the contrast improvement unit comprises: a signal conversion unit  
25 operable to convert a value of pixel in the input image to a signal that is an object of contrast improvement; an object correction data calculation unit operable to find a contrast improvement amount by comparing the object signal of the object pixel with the object signals of pixels that belong to each of surrounding areas with different sizes; an extraction unit  
30 operable to extract an effective range from distribution of the contrast

improvement amount for the object signal; an object signal conversion unit operable to convert a contrast improvement amount for the object signal to a value of the object signal in the enhanced image based on the extracted range; and a signal inverse conversion unit operable to find a value of  
5 pixel in the enhanced image based on the object signal of the enhanced image and signals other than the object signal obtained by the signal conversion unit.

9. The image processing apparatus of claim 7 or claim 8 wherein  
10 the object signal conversion unit comprises: an average object signal calculation unit operable to calculate an average value of the object signal in the input image; a conversion method selection unit operable to select a conversion method for converting the contrast improvement amount for the object signal to a value of the object signal in the enhanced image based on the average value; and an object signal estimation unit operable to convert the contrast improvement amount for the object signal to the value of the object signal in the enhanced image according to the selected  
15 conversion method.

20 10. The image processing apparatus of claim 7 or 8 wherein  
the object signal conversion unit comprises: a standard intensity calculation unit operable to calculate a standard intensity value that indicates contrast intensity of the input image for the object signal obtained by the signal conversion unit; an object signal conversion curve estimation unit operable to estimate a conversion curve for converting the contrast improvement amount for the object signal to the value in the enhanced image based on the standard intensity value; and an object signal estimation unit operable to use the estimated conversion curve to convert  
25 the contrast improvement amount for the object signal to the value in the enhanced image based on the standard intensity value; and an object signal estimation unit operable to use the estimated conversion curve to convert the contrast improvement amount for the object signal to the value in the  
30 enhanced image.

11. The image processing apparatus of claim 10 wherein  
the object signal conversion curve estimation unit comprises: an  
initial candidate setting unit operable to set an initial population of  
5 search vectors that indicate conversion curves; an object signal  
conversion candidate calculation unit operable to find a conversion value  
for the object signal in a candidate for an enhanced image from the contrast  
improvement amount for the object signal using a conversion curve candidate  
corresponding to each search vector; an evaluation value calculation unit  
10 operable to use the standard intensity value and the conversion value to  
calculate an evaluation value for evaluating the candidates of each  
conversion curve; a fitness calculation unit operable to calculate fitness  
of a candidate of each conversion curve based on the evaluation value;  
a recombination operation unit operable to perform recombination operation  
15 on a search vector selected based on the fitness of the candidates of each  
conversion curve and generate a next generation population; and an  
estimation end judgment unit operable to determine whether or not  
estimation of the conversion curve ends at current generation.

20 12. The image processing apparatus of claim 1 wherein  
the image combination unit comprises: a selection standard judgment  
unit operable to determine whether the input image or enhanced image has  
priority; a combination coefficient calculation unit operable to set  
combination coefficients for the input image and enhanced image based on  
25 the judgment of the selection standard judgment unit; and a weighted average  
combination unit operable to use the combination coefficients set for each  
image to generate a weighted average image of the input image and enhanced  
image.

30 13. An image processing apparatus comprising:

a contrast improvement unit operable to perform a contrast improvement process on an input image by comparing an object pixel of the input image with pixels that belong to surrounding areas of the object pixel;

an edge data detection unit operable to detect edge data of the input

5 image;

an image combination unit operable to combine an enhanced image obtained by the contrast improvement unit with the input image based on the edge data obtained by the edge data detection unit; and

an image output unit operable to output an image after combination.

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14. The image processing apparatus of claim 13 wherein

the contrast improvement unit comprises: a correction data calculation unit operable to find a contrast improvement amount for a pixel in the input image; an extraction unit operable to extract an effective range from distribution of the contrast improvement amount; and a pixel value conversion unit operable to convert a contrast improvement amount of the object pixel to a value of corresponding pixel in the enhanced image according to the extracted range.

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15. The image processing apparatus of claim 13 wherein

the contrast improvement unit comprises: a correction data calculation unit operable to find the contrast improvement amount by comparing the object pixel with pixels that belong to each of surrounding areas with different sizes; an extraction unit operable to extract an effective range from distribution of the contrast improvement amount; and a pixel value conversion unit operable to convert a contrast improvement amount of the object pixel to a value of corresponding pixel in the enhanced image according to the extracted range.

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16. The image processing apparatus of claim 13 wherein

the image combination unit comprises: a combination coefficient calculation unit operable to calculate combination coefficients for the input image and enhanced image based on the edge data obtained from the input image; and a weighted average combination unit operable to generate 5 a weighted average image for the input image and enhanced image based on the combination coefficients calculated for each image.

17. An image processing apparatus comprising:

a contrast improvement unit operable to perform a contrast improvement 10 process on an input image by comparing an object pixel in the input image with pixels that belong to surrounding areas of the object pixel;  
a density correction unit operable to correct density distribution of an enhanced image obtained by the contrast improvement unit according to density distribution of the input image;  
15 an image combination unit operable to combine a corrected image obtained by the density correction unit and the input image; and  
an image output unit operable to output an image after combination.

18. The image process apparatus of claim 17 wherein

20 the image combination unit comprises: a weighted average combination unit operable to generate a weighted average image for the input image and enhanced image; and an output value setting unit operable to set a value of pixel in an output image based on the image obtained by the weighted average combination unit and the input image.

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19. An image processing apparatus comprising:

an edge data detection unit operable to detect edge data of an input image;  
a contrast improvement unit operable to perform a contrast improvement 30 process on the input image by determining an area where an object pixel

belongs based on the edge data of the object pixel obtained by the edge data detection unit and brightness of the object pixel, and by comparing the object pixel with pixels that belong to surrounding areas of the object pixel;

5       an image combination unit operable to combine an enhanced image obtained by the contrast improvement unit and the input image; and  
          an image output unit operable to output an image after combination.

20. The image processing apparatus of claim 19 wherein  
10      the image combination unit comprises: a weighted average combination unit operable to generate a weighted average image for the input image and enhanced image; and an output value setting unit operable to set a value of pixel in the output image based on the image obtained by the weighted average combination unit and the input image.

15       21. An image processing apparatus comprising:  
          an edge data detection unit operable to extract edge data of an input image;  
          a contrast improvement unit operable to perform a contrast improvement process on the input image by determining an area where an object pixel belongs based on the edge data of the object pixel obtained by the edge data detection unit and brightness of the object pixel, and by comparing the object pixel with pixels that belong to surrounding areas of the object pixel;

20       an image combination unit operable to combine an enhanced image obtained by the contrast improvement unit and the input image based on the edge data obtained by the edge detection unit; and  
          an image output unit operable to output an image after combination.

30       22. The image processing apparatus of claim 19 or claim 21 wherein

the contrast improvement unit comprises: an area judgment unit operable to determine an area where the object pixel belongs based on edge data; a comparison range setting unit operable to select a pixel comparison range based on the area obtained by the area judgment unit; a correction data calculation unit operable to find a contrast improvement amount for the object pixel based on the pixel comparison range selected by the comparison range setting unit; an adjustment coefficient calculation unit operable to calculate an adjustment coefficient for the contrast improvement amount based on the area obtained by the area judgment unit; an adjustment unit operable to correct the contrast improvement amount using the adjustment coefficient obtained by the adjustment coefficient calculation unit; an extraction unit operable to extract an effective range from distribution of the corrected contrast improvement amount; and a pixel value conversion unit operable to convert the contrast improvement amount of the object pixel to a value of corresponding pixel in the enhanced image according to the extracted range.

23. The image processing apparatus of claim 19 or claim 21 wherein the contrast improvement unit comprises: an area judgment unit operable to determine an area where the object pixel belongs based on the edge data; a correction data calculation unit operable to find a contrast improvement amount by comparing the object pixel with a pixel that belongs to each of surrounding areas having different sizes; an adjustment coefficient calculation unit operable to calculate an adjustment coefficient for the contrast improvement amount based on the area obtained by the area judgment unit; an adjustment unit operable to correct the contrast improvement amount using the adjustment coefficient obtained by the adjustment coefficient calculation unit; an extraction unit operable to extract an effective range from distribution of the corrected contrast improvement amount; and a pixel value conversion unit operable to convert

the contrast improvement amount of the object pixel to a value of corresponding pixel in the enhanced image according to the extracted range.

24. An image processing apparatus comprising:

5       a contrast improvement unit having a correction data calculation density binding unit operable to bind density of a pixel in an area surrounding an object pixel in an input image, wherein the contrast improvement unit performs a contrast improvement process on the input image in the bound state by comparing the object pixel of the input image with  
10      pixels of the surrounding area; and  
            an image output unit operable to output an enhanced image obtained by the contrast improvement unit.

25. An image processing apparatus comprising:

15       a contrast improvement unit having a correction data calculation density binding unit operable to bind density of a pixel in an area surrounding an object pixel in an input image, wherein the contrast improvement unit performs a contrast improvement process on the input image in the bound state by comparing the object pixel of the input image with  
20      pixels of the surrounding area;  
            an image combination unit operable to combine an enhanced image obtained by the contrast improvement unit and the input image; and  
            an image output unit operable to output an image after combination.

25       26. The image processing apparatus of claim 24 or claim 25 wherein  
            the contrast improvement unit comprises: a correction data calculation unit operable to find a contrast improvement amount of the object pixel; an extraction unit operable to extract an effective range from distribution of contrast; and a pixel value conversion unit operable to convert the  
30      contrast improvement amount of the object pixel to a value of corresponding

pixel in the enhanced image.

27. The image processing apparatus of claim 24 or claim 25 wherein  
the contrast improvement unit comprises: a correction data calculation  
5 unit operable to find a contrast improvement amount by comparing the object  
pixel with pixels that belong to each of surrounding areas with different  
sizes; an extraction unit operable to extract an effective range from  
distribution of the contrast improvement amount; and a pixel value  
conversion unit operable to convert the contrast improvement amount of  
10 the object pixel to a value of corresponding pixel in the enhanced image.

28. An image processing apparatus comprising:

a pre-processing unit operable to perform pre-processing on an input  
image;

15 a contrast improvement unit operable to perform a contrast improvement  
process on the pre-processed image by comparing an object pixel of the  
pre-processed image with pixels that belong to surrounding areas of the  
object pixel;

an image combination unit operable to combine an enhanced image  
20 obtained by the contrast improvement unit and the input image;

a post-processing unit operable to perform post-processing on an image  
after combination; and

an image output unit operable to output the post-processed image.

25 29. The image processing apparatus of claim 28 wherein  
the contrast improvement unit comprises: a comparison pixel setting  
unit operable to set comparison pixels from among pixels in the area  
surrounding the object pixel to be used in the comparison; a correction  
data calculation unit operable to find a contrast improvement amount of  
30 the object pixel; a conversion standard value calculation unit operable

to find a conversion standard value for converting the contrast improvement amount to a value of pixel in the enhanced image; and a pixel value conversion unit operable to convert the contrast improvement amount to a value of pixel in the enhanced image based on the conversion standard 5 value.

30. The image processing apparatus of claim 29 wherein  
the correction data calculation unit comprises: a surrounding average  
unit operable to find a weighted average for density of the comparison  
10 pixels; and an improvement amount calculation unit operable to find a  
contrast improvement amount from the average density obtained by the  
surrounding average unit and density of the object pixel.

31. The image processing apparatus of claim 29 wherein  
15 the correction data calculation unit comprises: a surrounding average  
unit operable to find a weighted average for density of the comparison  
pixels; an edge data detection unit operable to detect edge data of the  
object pixel; a correction coefficient calculation unit operable to  
calculate a correction coefficient for the edge data based on the edge  
20 data obtained by the edge data detection unit; a comparison amount  
correction unit operable to correct the average density obtained by the  
surrounding average unit using the correction coefficient; and an  
improvement amount calculation unit operable to find a contrast  
improvement amount from the corrected average density and the density of  
25 the object pixel.

32. The image processing apparatus of claim 29 wherein  
the correction data calculation unit comprises: a surrounding average  
unit operable to find a weighted average for density of the comparison  
30 pixels; an improvement amount calculation unit operable to find a contrast

improvement amount from the average density obtained by the surrounding average unit and the density of the object pixel; an enhancement component calculation unit operable to calculate an enhancement component from difference in the density of the comparison pixel and the object pixel;  
5 and an improvement amount correction unit operable to add the enhancement component to the contrast improvement amount.

33. The image processing apparatus of claim 28 wherein  
the contrast improvement unit comprises: a comparison pixel setting  
10 unit operable to set positions in a vertical direction of pixels to be used in the comparison from among pixels in the area surrounding the object pixel; a vertical direction addition unit operable to add weighting in the vertical direction to the density of the comparison pixels obtained by the comparison pixel setting unit; a simple surrounding average unit  
15 operable to calculate comparison density for the object pixel from a value at each horizontal pixel position in the surrounding area obtained by the vertical direction addition unit; an improvement amount calculation unit operable to find a contrast improvement amount from the comparison density and density of the object pixel; a conversion standard value calculation  
20 unit operable to find a conversion standard value for converting the contrast improvement amount to a value of pixel in the enhanced image; and a pixel value conversion unit operable to convert the contrast improvement amount to a value of pixel in the enhanced image based on the conversion standard value.

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34. The image processing apparatus of claim 28 wherein  
the contrast improvement unit comprises: a comparison pixel setting  
unit operable to set positions in a vertical direction and positions in  
a horizontal direction of pixels to be used in the comparison from among  
30 pixels in the area surrounding the object pixel ; a removal vertical

direction addition unit operable to add weighting to the vertical direction of the density of the comparison pixels obtained by the comparison pixel setting unit; a simple surrounding average unit operable to calculate comparison density for the object pixel based on an addition value obtained  
5 by the removal vertical direction addition unit; an improvement amount calculation unit operable to find a contrast improvement amount from the comparison density and density of the object pixel; a conversion standard value calculation unit operable to find a conversion standard value for converting the contrast improvement amount to a value of pixel in the  
10 enhanced image; and a pixel value conversion unit operable to convert the contrast improvement amount to a value of pixel in the enhanced image based on the conversion standard value.

35. The image processing apparatus of claim 28 wherein  
15 the pre-processing unit performs inverse conversion of gamma conversion on the input image in advance.

36. The image processing apparatus of claim 35 wherein  
the post-processing unit performs the gamma conversion.

20  
37. The image processing apparatus of claim 28 wherein  
the post-processing unit comprises: an input brightness/color calculation unit operable to calculate a brightness value and color difference components of the input image; a brightness adjustment unit  
25 operable to compare a brightness component of the input image obtained by the input brightness/color calculation unit with the brightness component of a combined image and adjust the brightness component of the combined image; a color component correction unit operable to correct the color difference components of the input image obtained by the input  
30 brightness/color calculation unit based on the brightness component of

the combined image obtained by the brightness adjustment unit; an image regeneration unit operable to regenerate the combined image using the brightness component of the combined image obtained by the brightness adjustment unit and the corrected color difference components obtained 5 by the color component correction unit; and a gamma conversion unit operable to perform gamma conversion on the combined image obtained by the image regeneration unit.

38. An image processing method comprising:

10 a contrast improvement step of performing a contrast improvement process on an input image by comparing an object pixel of the input image with pixels that belong to surrounding areas of the object pixel;  
an image combination step of combining an enhanced image obtained from the contrast improvement unit and the input image; and  
15 a step of outputting an image after combination.

39. The image processing method of claim 38 wherein

the contrast improvement step comprises: a step of finding a contrast improvement amount for a pixel in the input image; a step of extracting 20 an effective range from distribution of the contrast improvement amount; and a pixel value conversion step of converting the contrast improvement amount of the object pixel to a value of corresponding pixel in the enhanced image according to the extracted range.

25 40. The image processing method of claim 38 wherein

the contrast improvement step comprises: a step of finding a contrast improvement amount by comparing the object pixel with pixels that belong to each of surrounding areas with different sizes; a step of extracting 30 an effective range from distribution of the contrast improvement amount; and a pixel value conversion of converting the contrast improvement amount

of the object pixel to a value of corresponding pixel in the enhanced image according to the extracted range.

41. The image processing method of claim 39 or 40 wherein  
5       the pixel value conversion step comprises: a step of calculating an average brightness of pixels in the input image; a step of selecting a method of converting the contrast improvement amount to a value of pixel in the enhanced image based on the average brightness; and a step of converting the contrast improvement amount to a value of pixel in the 10 enhanced image according to the selected conversion method.

42. The image processing method of claim 39 or 40 wherein  
15      the pixel value conversion step comprises: a step of calculating the standard intensity value that indicates contrast intensity of the input image; a conversion curve estimation step of estimating a conversion curve for converting the contrast improvement amount to a value in the enhanced image; and a step of using the conversion curve to convert the contrast improvement amount to a value in the enhanced image.

20       43. The image processing method of claim 42 wherein  
          the conversion curve estimation step comprises: a step of setting an initial population of search vectors that indicate conversion curves; a step of finding a conversion value in a candidate for an enhanced image from the contrast improvement amount using a conversion curve candidate 25 corresponding to each search vector; a step of using the standard intensity value and the conversion value to calculate an evaluation value for evaluating the candidates of each conversion curve; a step of calculating fitness of a candidate of each conversion curve based on the evaluation value; a step of performing recombination operation on a search vector 30 selected based on the fitness of the candidates of each conversion curve

and generating a next generation population; and a step of determining whether or not estimation of the conversion curve ends at current generation.

44. The image processing method of claim 38 wherein

5       the contrast improvement step comprises: a signal conversion step of converting a value of pixel in the input image to a plurality of signals that include the signal that is an object of contrast improvement; a step of finding a contrast improvement amount of the object pixel for an object signal obtained from the signal conversion step; a step of extracting an  
10      effective range from distribution of the contrast improvement amount for the object signal; an object signal conversion step of converting the contrast improvement amount for the object signal to a value of the object signal in the enhanced image; and a step of finding a value of pixel in the enhanced image based on the object signal of the enhanced image and  
15      signals other than the object signal obtained by the signal conversion step.

45. The image processing method of claim 38 wherein

the contrast improvement step comprises: a signal conversion step of  
20      converting a value of pixel in the input image to a signal that is an object of contrast improvement; a step of finding a contrast improvement amount by comparing the object signal of the object pixel with the object signals of pixels that belong to each of surrounding areas with different sizes; a step of extracting an effective range from distribution of the contrast improvement amount for the object signal; an object signal conversion step of converting the contrast improvement amount for the object signal to a value of the object signal in the enhanced image based on the extracted range; and a step of finding a value of pixel in the enhanced image based  
25      on the object signal of the enhanced image and signals other than the object signal obtained by the signal conversion step.  
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46. The image processing step of claim 44 or claim 45 wherein  
the object signal conversion step comprises: a step of calculating  
an average value of the object signal in the input image; a step of selecting  
5 a conversion method for converting the contrast improvement amount for  
the object signal to a value of the object signal in the enhanced image  
based on the average value; and step of converting the contrast improvement  
amount for the object signal to a value of the object signal in the enhanced  
image according to the selected conversion method.

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47. The image processing method of claim 44 or 45 wherein  
the object signal conversion step comprises: a step of calculating  
a standard intensity value that indicates contrast intensity of the input  
image for the object signal obtained by the signal conversion step; an  
15 object signal conversion curve estimation step of estimating a conversion  
curve for converting the contrast improvement amount for the object signal  
to a value in the enhanced image; and a step of using the estimated  
conversion curve to convert the contrast improvement amount for the object  
signal to a value in the enhanced image.

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48. The image processing method of claim 47 wherein  
the object signal conversion curve estimation step comprises: a step  
of setting an initial population of search vectors that indicate conversion  
curves; a step of finding conversion value for the object signal in a  
25 candidate for an enhanced image from the contrast improvement amount for  
the object signal using a conversion curve candidate corresponding to each  
search vector; a step of using the standard intensity value and the  
conversion value to calculate an evaluation value for evaluating the  
candidates of each conversion curve; a step of calculating fitness of the  
30 candidates of each conversion curve based on the evaluation value; a step

of performing recombination operation on a search vector selected based on the fitness of the candidates of each conversion curve and generating a next generation population; and a step of determining whether or not estimation of the conversion curve ends at current generation.

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49. The image processing method of claim 38 wherein  
the image combination step comprises: a selection standard judgment  
step of determining whether the input image or enhanced image has priority;  
a combination coefficient calculation step of setting combination  
coefficients for the input image and enhanced image based on the judgment  
of the selection standard judgment step; and a step of using the combination  
coefficients set for each image to generate a weighted average image of  
the input image and enhanced image.

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50. An image processing method comprising:  
a contrast improvement step of performing a contrast improvement  
process on an input image by comparing an object pixel of the input image  
with pixels that belong to surrounding areas of the object pixel;  
an edge data detection step of detecting edge data of the input image;  
20 an image combination step of combining an enhanced image obtained by  
the contrast improvement step with the input image based on the edge data  
obtained by the edge data detection step; and  
a step of outputting an image after combination.

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51. The image processing method of claim 50 wherein  
the contrast improvement step comprises: a step of finding a contrast  
improvement amount for a pixel in the input image; a step of extracting  
an effective range from distribution of the contrast improvement amount;  
and a step of converting the contrast improvement amount of the object  
30 pixel to a value of corresponding pixel in the enhanced image according

to the extracted range.

52. The image processing method of claim 50 wherein  
the contrast improvement step comprises: a step of finding the contrast  
5 improvement amount by comparing the object pixel with a pixel that belong  
to each of surrounding areas of different sizes; a step of extracting an  
effective range from distribution of the contrast improvement amount; and  
a step of converting the contrast improvement amount of the object pixel  
to a value of corresponding pixel in the enhanced image according to the  
10 extracted range.

53. The image processing method of claim 50 wherein  
the image combination step comprises: a step of calculating  
combination coefficients for the input image and enhanced image based on  
15 the edge data obtained from the input image; and a step of generating a  
weighted average image for the input image and enhanced image based on  
the combination coefficients calculated for each image.

54. An image processing method comprising:  
20 a contrast improvement step of performing a contrast improvement  
process on an input image by comparing an object pixel in the input image  
with pixels that belong to surrounding areas of the object pixel;  
a density correction step of correcting density distribution of an  
enhanced image obtained by the contrast improvement step according to  
25 density distribution of the input image;  
a step of combining a corrected image obtained by the density  
correction step and the input image; and  
a step of outputting an image after combination.

30 55. The image process method of claim 54 wherein

the image combination step comprises: a weighted average combination step of generating a weighted average image for the input image and corrected image; and a step of setting a value of pixel in an output image based on the image obtained by the weighted average combination step and  
5 the input image.

56. An image processing method comprising:

an edge data detection step of detecting edge data of an input image;  
a contrast improvement step of performing a contrast improvement  
10 process on the input image by determining an area where an object pixel belongs based on the edge data of the object pixel obtained by the edge data detection step and brightness of the object pixel, and by comparing the object pixel with pixels that belong to surrounding areas of the object pixel;  
15 an image combination step of combining an enhanced image obtained by the contrast improvement step and the input image; and  
a step of outputting an image after combination.

57. The image processing method of claim 56 wherein

20 the image combination step comprises: a weighted average combination step of generating a weighted average image for the input image and enhanced image; and a step of setting a value of pixel in the output image based on the image obtained by the weighted average combination step and the input image.

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58. The image processing method of claim 56 wherein  
the contrast improvement step comprises: an area judgment step of determining an area where the object pixel belongs based on edge data; a comparison range setting step of selecting a pixel comparison range based  
30 on the area obtained by the area judgment step; a step of finding a contrast

improvement amount for the object pixel based on the pixel comparison range selected by the comparison range setting step; an adjustment coefficient calculation step of calculating an adjustment coefficient for the contrast improvement amount based on the area obtained by the area judgment step;

5       a step of correcting the contrast improvement amount using the adjustment coefficient obtained by the adjustment coefficient calculation step; a step of extracting an effective range from the corrected contrast improvement amount; and a step of converting the contrast improvement amount of the object pixel to a value of corresponding pixel in the enhanced

10      image according to the extracted range.

59. The image processing method of claim 56 wherein  
the contrast improvement step comprises: an area judgment step of determining an area where the object pixel belongs based on edge data;

15      a step of finding a contrast improvement amount by comparing the object pixel with a pixel that belongs each of surrounding areas having different sizes; an adjustment coefficient calculation step of calculating an adjustment coefficient for the contrast improvement amount based on the area obtained by the area judgment step; a step of correcting the contrast

20      improvement amount using the adjustment coefficient obtained by the adjustment coefficient calculation step; a step of extracting an effective range from the corrected contrast improvement amount; and a step of converting the contrast improvement amount of the object pixel to a value of corresponding pixel in the enhanced image according to the extracted

25      range.

60. An image processing method comprising:  
a contrast improvement step of performing a contrast improvement process, in a state that density of a pixel in an area surrounding an object

30      pixel in an input image is bound, on the input image by comparing the object

pixel of the input image with a pixel of the surrounding area; and  
a step of outputting an enhanced image obtained by the contrast improvement step.

5        61. An image processing method comprising:

a contrast improvement step of performing a contrast improvement process, in a state that density of a pixel in an area surrounding an object pixel in an input image is bound, on the input image by comparing the object pixel of the input image with a pixel of the surrounding area;

10        a step of combining an enhanced image obtained by the contrast improvement step and the input image; and  
a step of outputting an image after combination.

15        62. The image processing method of claim 60 or claim 61 wherein the contrast improvement step comprises: a step of finding a contrast improvement amount of the object pixel; a step of extracting an effective range from distribution of contrast; and a step of converting the contrast improvement amount of the object pixel to a value of corresponding pixel in the enhanced image.

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63. The image processing method of claim 60 or claim 61 wherein the contrast improvement step comprises: a step of finding a contrast improvement amount by comparing the object pixel with pixels that belong to each of surrounding areas with different sizes; a step of extracting an effective range from distribution of the contrast improvement amount; and a step of converting the contrast improvement amount of the object pixel to a value of corresponding pixel in the enhanced image.

25        64. An image processing method comprising:

30        a pre-processing step of performing pre-processing on an input image;

a contrast improvement step of performing a contrast improvement process on the pre-processed image by comparing an object pixel of the pre-processed image with pixels that belong to surrounding areas of the object pixel;

5 a step of combining an enhanced image obtained by the contrast improvement step and the input image;

a post-processing step of performing post-processing on an image after combination; and

a step of outputting the post-processed image.

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65. The image processing method of claim 64 wherein the contrast improvement step comprises: a step of setting a comparison pixel from among pixels in the area surrounding the object pixel to be used in the comparison; a correction data calculation step of finding a contrast improvement amount of the object pixel; a step of finding a conversion standard value for converting the contrast improvement amount to a value of pixel in the enhanced image; and a step of converting the contrast improvement amount to a value of pixel in the enhanced image based on the conversion standard value.

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66. The image processing method of claim 65 wherein the correction data calculation step comprises: a surrounding average step of finding a weighted average for density of the comparison pixels; and a step of finding a contrast improvement amount from the average density obtained by the surrounding average step and density of the object pixel.

67. The image processing method of claim 65 wherein the correction data calculation step comprises: a surrounding average step of finding a weighted average for the density of the comparison pixels; 30 an edge data detection step of detecting edge data of the object pixel;

a step of calculating a correction coefficient for the edge data based on the edge data obtained by the edge data detection step; a step of correcting the average density obtained by the surrounding average step using the correction coefficient; and a step of finding a contrast improvement amount from the corrected average density and the density of the object pixel.

68. The image processing method of claim 65 wherein  
the correction data calculation step comprises: a surrounding average  
step of finding a weighted average for density of the comparison pixels;  
a step of finding a contrast improvement amount from the average density  
obtained by the surrounding average step and the density of the object  
pixel; a step of calculating an enhancement component from difference in  
the density of the comparison pixel and the object pixel; and a step of  
adding the enhancement component to the contrast improvement amount to  
correct the contrast improvement amount.

69. The image processing method of claim 64 wherein  
the contrast improvement step comprises: a step of setting positions  
in a vertical direction of pixels to be used in the comparison from among  
pixels in the area surrounding the object pixel; a vertical direction  
addition step of adding weighting in the vertical direction to the density  
of the comparison pixels obtained by the setting; a step of calculating  
comparison density for the object pixel from a value at each horizontal  
pixel position in the surrounding area obtained by the vertical direction  
addition step; a step of finding a contrast improvement amount from the  
comparison density and density of the object pixel; a step of finding a  
conversion standard value for converting the contrast improvement amount  
to a value of pixel in the enhanced image; and a step of converting the  
contrast improvement amount to a value of the pixel in the enhanced image

based on the conversion standard value.

70. The image processing method of claim 64 wherein  
the contrast improvement step comprises: a step of setting positions  
5 in a vertical direction and positions in a horizontal direction of pixels  
to be used in the comparison from among pixels in the area surrounding  
the object pixel; a removal vertical direction addition step of adding  
weighting to the vertical direction of the density of the comparison pixels  
obtained by the setting; a step of calculating comparison density for the  
10 object pixel based on an addition value obtained by the removal vertical  
direction addition step; a step of finding a contrast improvement amount  
from the comparison density and density of the object pixel; a step of  
finding a conversion standard value for converting the contrast  
improvement amount to a value of pixel in the enhanced image; and a step  
15 of converting the contrast improvement amount to a value of pixel in the  
enhanced image based on the conversion standard value.

71. The image processing method of claim 64 wherein  
the pre-processing performs inverse conversion of gamma conversion  
20 on the input image in advance.

72. The image processing method of claim 64 wherein  
the post-processing performs gamma conversion.

25 73. The image processing method of claim 64 wherein  
the post-processing step comprises: an input brightness/color  
calculation step of calculating a brightness value and color difference  
components of the input image; a brightness adjustment step of comparing  
a brightness component of the input image obtained by the input  
30 brightness/color calculation step with the brightness component of a

combined image and adjusting the brightness component of the combined image; a color component correction step of correcting the color difference components of the input image obtained by the input brightness/color calculation step based on the brightness component of the combined image  
5 obtained by the brightness adjustment step; an image regeneration step of regenerating the combined image using the brightness component of the combined image obtained by the brightness adjustment step and the corrected color difference components obtained by the color component correction step; and a step of performing gamma conversion on the combined image  
10 obtained by the image regeneration step.